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Kemp's Ridley Sea Turtle Head Start Operations of the NMFS SEFC Galveston Laboratory

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The Kemp's Ridley Sea Turtle Head Start Research Project is part of the U.S.-Mexico Kemp's Ridley Recovery Program, and has as its main objective the establishment of a new nesting colony at the Padre Island National Seashore near Corpus Christi, Tex. As of October 1988, 13,572 tagged Kemp's ridley sea turtle (Lepidochelys kempi) juveniles had been released into the Gulf of Mexico after being reared in captivity at the National Marine Fisheries Service (NMFS), Southeast Fisheries Center (SEFC), Galveston Laboratory in Galveston, Tex.

Each year during the nesting season, approximately 2,000 eggs are collected by the U.S. Fish and Wildlife Service and its contractor, Gladys Porter Zoo, from the beach at Rancho Nuevo, Tamaulipas, Mexico. The eggs are placed in Padre Island sand within polystyrene foam boxes for incubation. Once all the eggs have been collected, the boxes are flown to the National Seashore where the eggs are further incubated and hatched, and the hatchlings imprinted on the beach and in the surf at Padre Island, under surveillance by National Park Service personnel.

The imprinted hatchlings are transferred to the NMFS SEFC Galveston Laboratory where they are reared in sea water raceways, in isolation from each other in individual containers, for 9 to 11 months. Survivors in good condition are tagged, weighed and measured, and released into the Gulf of Mexico, usually off Padre and Mustang Islands.

Feeding, maintenance and health care of the turtles, the major activities of captive-rearing, are described. Other activities described include: (1) monthly weighings of samples of turtles to obtain average body weight from which feeding ration is determined as a percentage of body weight; (2) tagging by three methods (living tags, internal tags and flipper tags); (3) removal and preservation of kidneys and gonads (from turtles that die) for sex determination; and (4) final weighing and measuring of each turtle before it is released.

Hatchlings weigh around 14 grams when received in July and August. By late May or early June of the following year, the captive turtles have increased in average weight to 0.8 kg, at which size they are released into the Gulf.

Kemp's ridley sea turtle (*Lepidochelys kempi*) is listed as endangered under the U.S. Endangered Species Act of 1973. Its primary nesting site is a beach bordering the Gulf of Mexico near the village of Rancho Nuevo, in the State of Tamaulipas, Mexico (Chávez, Contreras and Hernandez, 1968). Hildebrand (1963) estimated that 40,000 female Kemp's ridleys nested on this beach on one day in June 1947, but by 1982 the number had declined to about 1,500 (Márquez, Villanueva and Sanchez, 1982; Márquez, 1983). The primary cause of the population decline has been overexploitation of the turtles (both directed and incidental) and the eggs by man. Since 1966, the beach near Rancho Nuevo has been protected during the nesting season from April to July by Mexican Marines and personnel of the Instituto Nacional de la Pesca (INP) of Mexico, with assistance from the U.S. Fish and Wildlife Service (FWS) and others. This protection has reduced the poaching by man (Márquez *et al.*, 1982).

Since 1978, the National Marine Fisheries Service (NMFS), Southeast Fisheries Center (SEFC), Galveston Laboratory has participated in an international program to save Kemp's ridley from extinction (Klima and McVey, 1982). The program is a joint conservation effort among the INP, FWS, NMFS, National Park Service (NPS) and Texas Parks and Wildlife Department (TPWD), with assistance from Gladys Porter Zoo, Brownsville, Tex. and others. The goal of the Kemp's ridley recovery program is to increase the Kemp's ridley population. The approach includes protection of nesting turtles and their eggs on the beach at Rancho Nuevo, prohibitions on the capture, possession and sale of the turtles, their eggs and turtle products, promotion of use of trawling efficiency devices (TED) to allow escapement of turtles captured incidentally in shrimp trawls, and experimental head starting of Kemp's ridley in captivity during its critical first year of life. The head started turtles are released into the Gulf of Mexico in hopes of establishing a new nesting colony at the Padre Island National Seashore, near Corpus Christi, Tex. For the latter purpose, most of the head started Kemp's ridley are imprinted as hatchlings at Padre Island, but others have been imprinted at Rancho Nuevo in hopes of supplementing that breeding colony as well.

Imprinting is defined as species-specific, rapid learning during a critical time of early life in which social attachment

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and identification are established. One working hypothesis of the head start project is that imprinting occurs during incubation and hatching of the eggs in beach sand, during exposure of hatchlings to the beach and adjacent surf, or both. Imprinting is assumed to act through memory to guide adult turtles back to their natal beach. At Rancho Nuevo each season, a small proportion of the eggs is taken for head starting. These eggs are collected in plastic bags as they are laid so they do not touch the local beach sand. They are placed in polystyrene foam boxes containing beach sand from Padre Island and are flown to the Padre Island National Seashore where they are placed in a hatchery and allowed to continue incubation. NPS biologists carefully monitor environmental conditions in the boxes during the incubation phase that normally takes 43 to 53 days (Robert King, NPS, personal communication, July 1984). Hatchlings are taken to the beach and allowed to crawl across the sand to the surf to enhance their opportunity for imprinting. The hatchlings are collected from the surf, placed in boxes lined with water-saturated, polyurethane foam cushions and transported by NPS personnel to Galveston.

Head starting undoubtedly increases survival of the young Kemp's ridleys during their first year, and their larger size upon release is thought to give them a subsequent survival advantage as compared to their natural counterparts (Márquez, 1972; Klima and McVey, 1982; Fontaine, Leong and Caillouet, 1983; Caillouet, 1984; Fontaine *et al.*, 1985). Natural survival of this turtle during its critical first year of life in the wild may be less than 1 percent. Survival during head starting the 1978-1987 year-classes has ranged from 67.8 to 98.4 percent. Of the total of 16,538 hatchlings received alive from year-classes 1978 to 1987, 13,572 (82.1 percent) had been reared, tagged and released as of October 1988.

This paper describes the facilities and methods used to rear, tag and release head started Kemp's ridleys (see also Fontaine *et al.*, 1985; Fontaine *et al.*, 1989).

Facilities

Quonset Huts

The sea turtle head start research facilities at the Galveston Laboratory consist of three, 9 x 20 meter, aluminum-framed quonsets huts manufactured by X. S. Smith, Inc., Red Bank, N.J. Each is covered by inflated, double-layered white polyethylene sheathing (Figure 1). The long axis of each quonset hut is situated on an northeast-southwest orientation parellel to the coastline so that prevailing winds provide cross-ventilation to cool the interior during summer. Sides of the quonset huts are equipped with lateral vent-rails located 1.2 meters above ground level. Panels of polyethylene sheathing attached to the rails can be removed during summer to allow ventilation. The quonset huts also are equipped with ventilation fans at one end. The space between the double-layered, polyethylene covers is inflated by small blowers to approximately 20 cm. This air-space between the layers provides insulation. The tops normally last only 12 to 18 months, so they are replaced annually following the hurricane season and before winter. Gas-fired, forced air heaters are used during the winter to maintain warm temperatures.

Seawater Supply

Seawater is pumped through submerged well-points located approximately 200 meters seaward of the surfline of Galveston's beach bordering the Gulf of Mexico. The seawater is stored initially in an underground, concrete sump (113,460 liters) and then pumped into two above-ground, fiberglass-lined redwood storage tanks (each 94,550 liters). Seawater is then delivered from the redwood tanks to eight, above-ground, insulated, fiberglass reservoirs near the head start facilities. Figure 2 shows the four smaller reservoirs, each with a capacity of 28,390 liters, and two of the larger ones, each with a capacity of 37,850 liters. The other two reservoirs (not shown) also have a 37,850 liter capacity. During cold weather, seawater is heated by thermostatically-controlled, immersion heaters (Table 1) to maintain temperatures at 25° to 28° C.

Raceways

The 27 fiberglass raceways used to rear the turtles were manufactured by Red Ewald, Inc., Karnes City, Tex. The raceways are rectangular (Figure 3), measuring 6.1 meters long x 1.8 meters wide x 0.6 meters deep. They are filled to a depth of 30 cm, providing a seawater volume of 3,140 liters per raceway.

Isolation Rearing Containers

Hatchling Kemp's ridley are aggressive and will attack and injure each other (Klima and McVey 1982; Bjorndal and Balazs, 1983). Consequently, they cannot be reared together without high mortality. Therefore, each turtle is reared in isolation either in plastic buckets or boxes. Each raceway usually contains 18 rows of six plastic buckets, 28 cm deep x 22 cm (inside top diameter), suspended with 10-gauge galvanized wire from 18 5.1 cm x 5.1 cm wooden poles, placed across the width of the raceways (Figure 4). The 18 rows are lettered A-R from southeast to northwest, and the six columns are numbered 1-6 from northeast to southwest, providing a total of 108 buckets per raceway. The bottom of each bucket is drilled with 12 holes, each 2.5 cm in diameter, to allow water exchange and liberation of turtle excrement and uneaten food. A raceway can contain 16 rows of five plastic boxes (not shown; see Caillouet *et al.*, 1988) of the kind

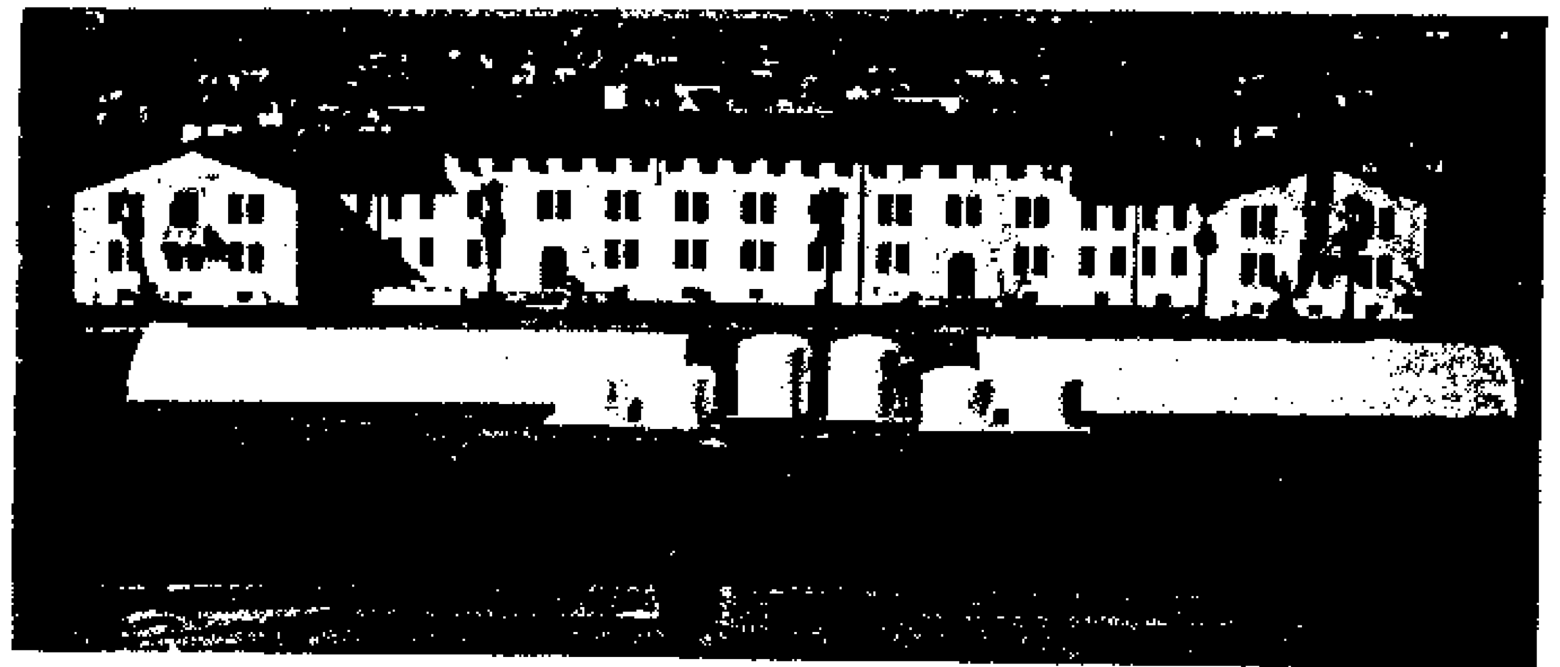
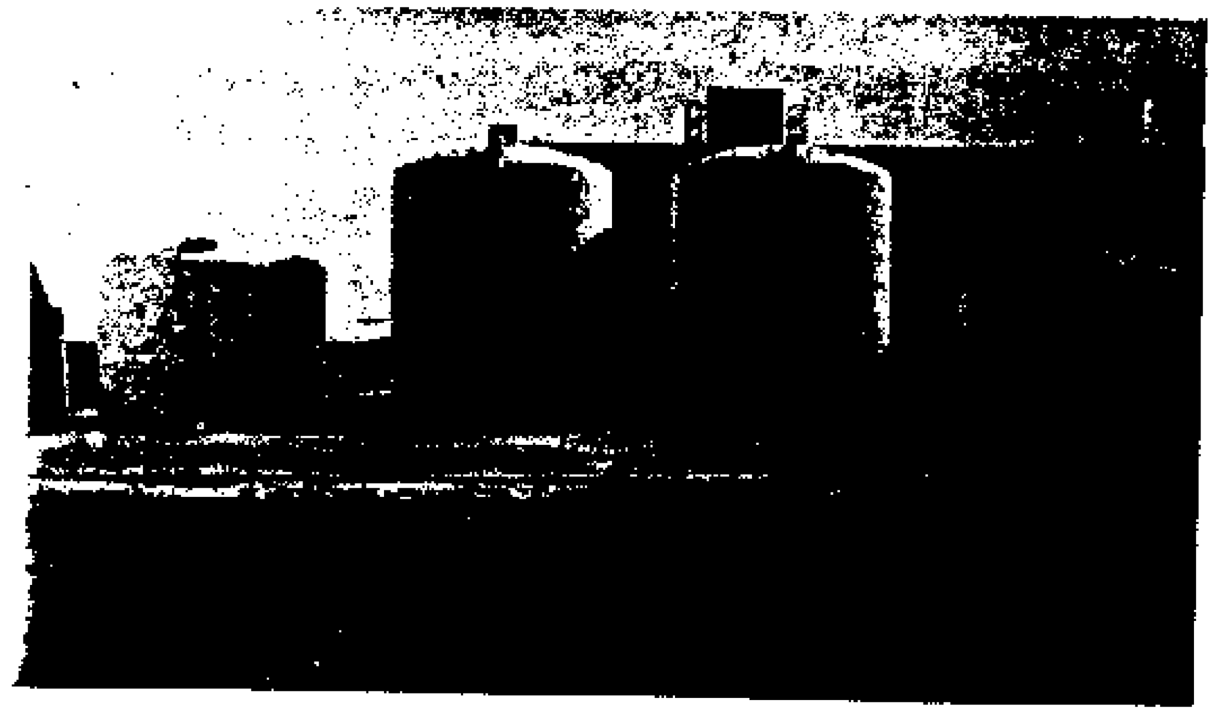


Figure 1. Kemp's ridley sea turtle head start research facilities (quonset huts and sea turtle reservoirs in middleground), NMFS SEFC Galveston Laboratory.

Figure 2. Insulated, fiberglass seawater reservoirs supported by 15 cm thick, steel-reinforced, concrete pads (four additional reservoirs are not shown).



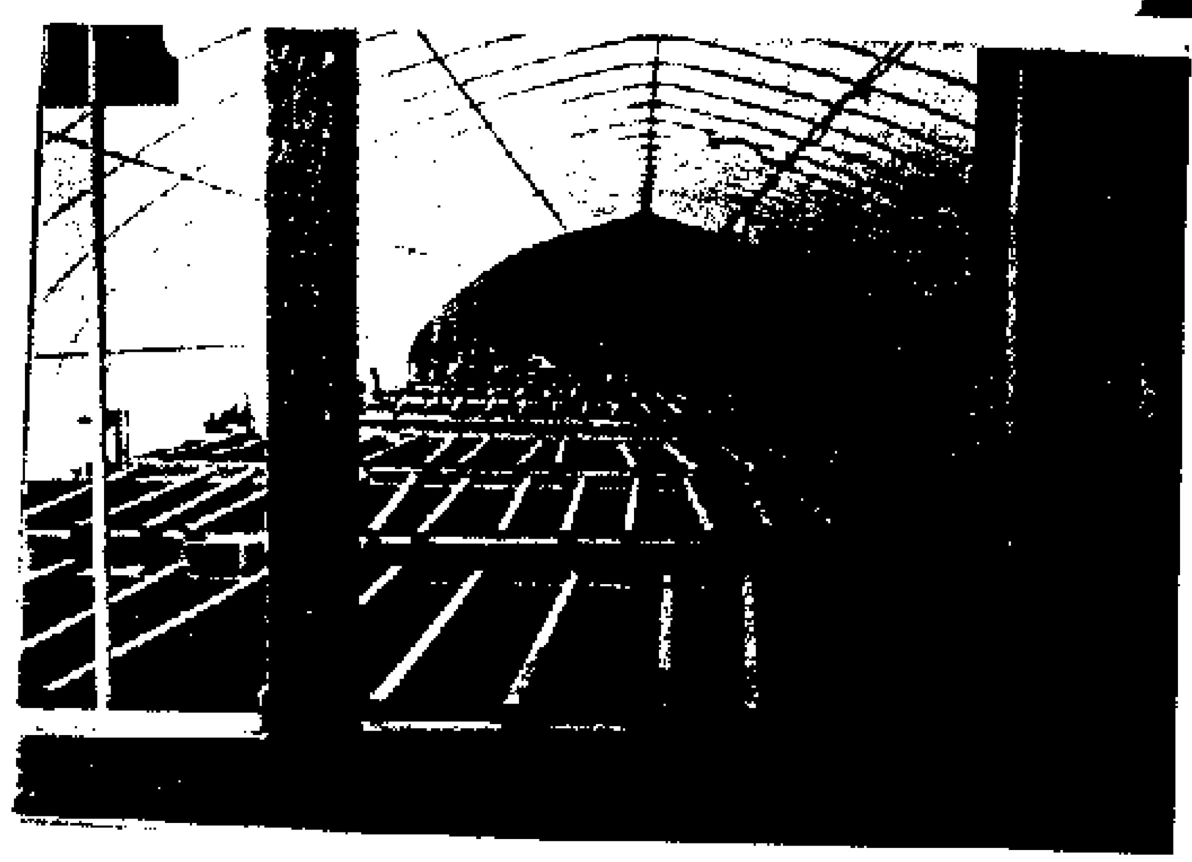


Figure 3. Raceways (viewed from the side) used in rearing Kemp's ridley sea turtles.

Figure 4. The buckets used for isolation rearing of Kemp's ridley sea turtles to prevent aggressive attacks.

Table 1. Specifications, uses and suppliers of equipment and materials.

Description	Use	Supplier
Fiberglass raceways, basins, digestion tanks, and seawater reservoirs	Holding turtles, treating wastewater, and storing seawater	Red Ewald, Inc. PO Box 519 Karnes City, TX 78118
Positive air-blowers, 2.7 HP (Cyclonair #CH5)	Aeration of digestion tanks	Rotron, Inc. Mansfield, OH
Centrifugal pump, 2 HP (Gorman-Rupp #B0024FCF2A4)	Seawater delivery	Pump & Power Equipment 800 Harwin, Dr., Ste. 370 Houston, TX 77036
Submersible sump pump, 496 liters/min at 1.5 m head (Teel pump #3P650)	Pumping untreated wastewater	Granger, Inc. 7777 Parnell St. Houston, TX
Plastic buckets, 10 liter volume 22 cm inside top diameter, 28 cm depth	Containers for individual sea turtles	Loma Plastics, Inc. Fort Worth, TX
Quonset hut covers (Loratex, UV Treated)	Tops for quonset huts	Farms Supply Co. 500 Clarkesville St. Cornelia, GA 30351
Titanium immersion heaters	Heating seawater in reservoirs	Glo-Quartz Electric Heater 7074-7190 Maple St. Mentor, OH 40051

used to transport plastic, 3.8-liter milk jugs. Dimensions of these boxes are 33.0 cm long x 31.1 cm wide x 30.5 cm deep.

Each turtle remains in its assigned bucket or box throughout the head start process, unless it dies or becomes ill. The raceway and bucket or box locations provide codes used as identifiers for individual turtles throughout head starting. In this way, the clutch-of-origin identity of each turtle is maintained, and can be linked through records to the female that laid the clutch.

Turtles that outgrow their containers are transferred to plastic laundry baskets suspended in a raceway or to fiberglass basins (Figure 5). These hemispherical basins are 61 cm in diameter and 25 cm deep and usually filled with 26.5 liters of seawater. The seawater is exchanged and the basins cleaned on a daily basis.

When ill, a turtle is transferred to sick bay (Figure 6) where it is treated, then returned to its bucket or box if it is cured. The sick bay (Figure 6) where sick turtles are isolated for observation and treatment contains fiberglass basins similar to those described in the previous paragraph. When in use, the basins are drained, scrubbed with a heavy brush, rinsed, and filled with clean seawater on a daily basis.

Seawater Exchanges and Cleaning

All raceways are drained and seawater replaced three times a week (Monday, Wednesday and Friday). Once a week, each raceway is thoroughly cleaned by draining the seawater, washing down the turtles, buckets and raceway with freshwater (tapwater), rinsing out the raceway with freshwater, scrubbing the inside walls of the raceway with heavy-duty brushes or power sprayers to remove attached algae, rinsing the raceway once again with freshwater, and refilling the raceway with

Figure 5. Hemispherical fiberglass basins .

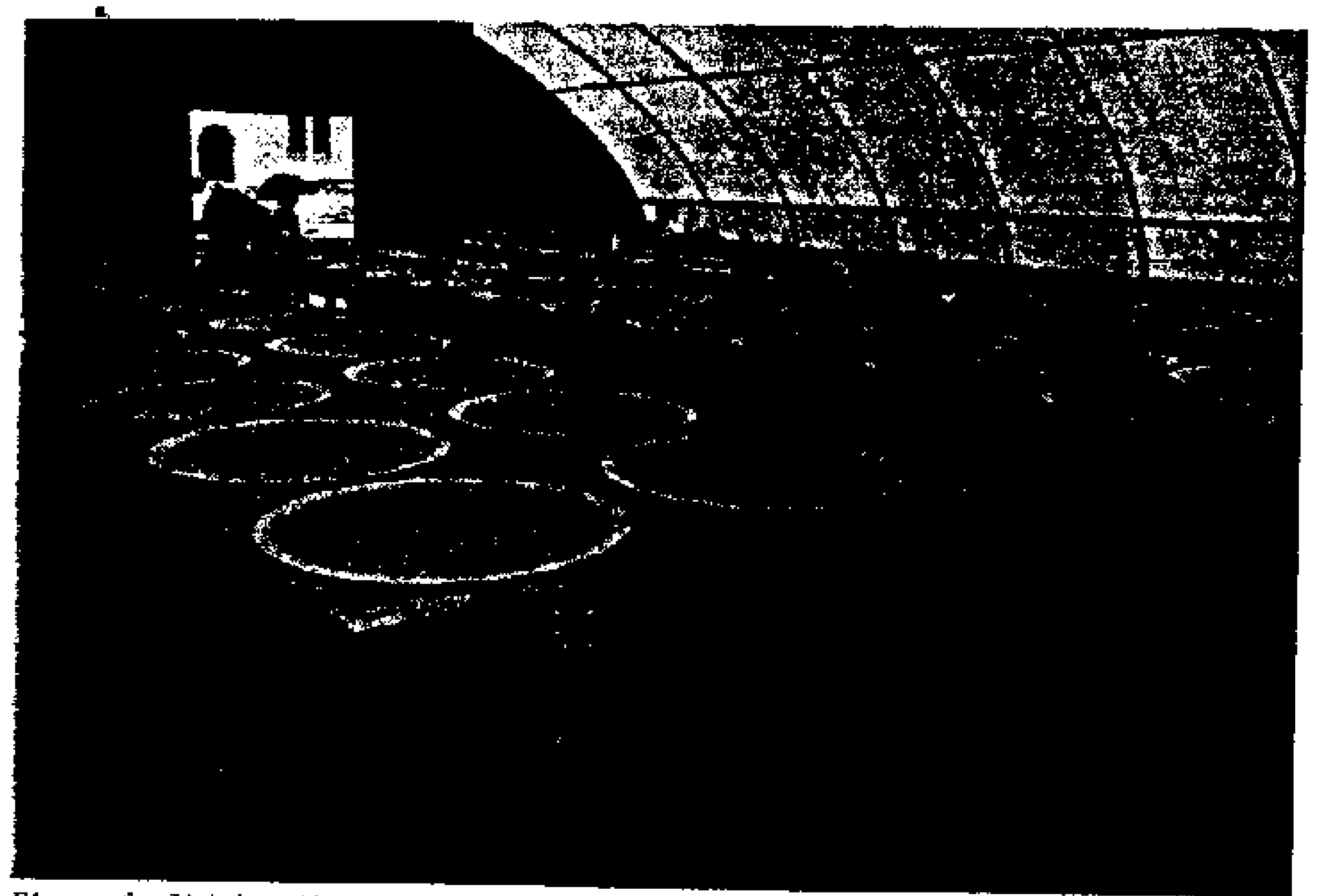


Figure 6. Sick-bay (for isolation and treatment) containing hemispherical basins.

Figure 7. Raceway standpipe system that prevents overfilling of raceways and allows quick drainage.

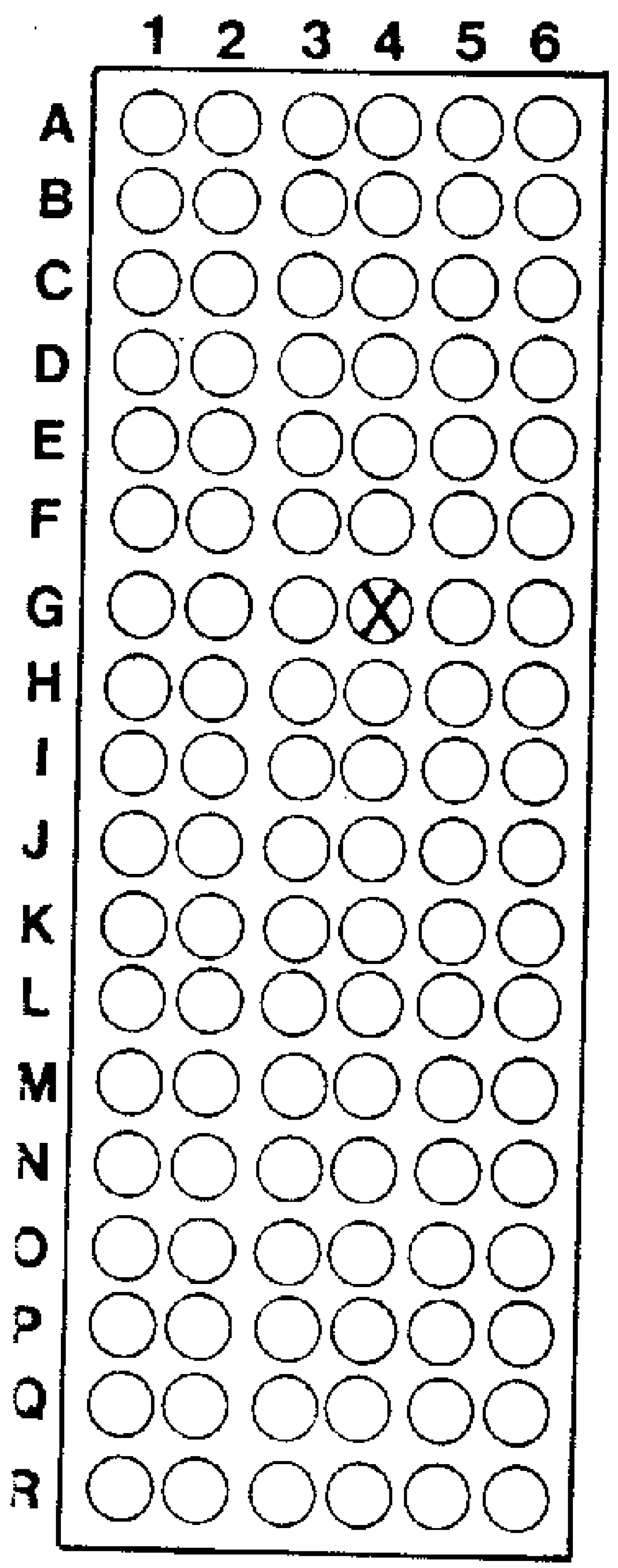


Figure 9. Code system used for eighteen rows (lettered A-R) and six columns (numbered 1-6) of buckets. X marks bucket location 83-1-G-4 (for 1983 year-class, raceway 1, row G and column 4).

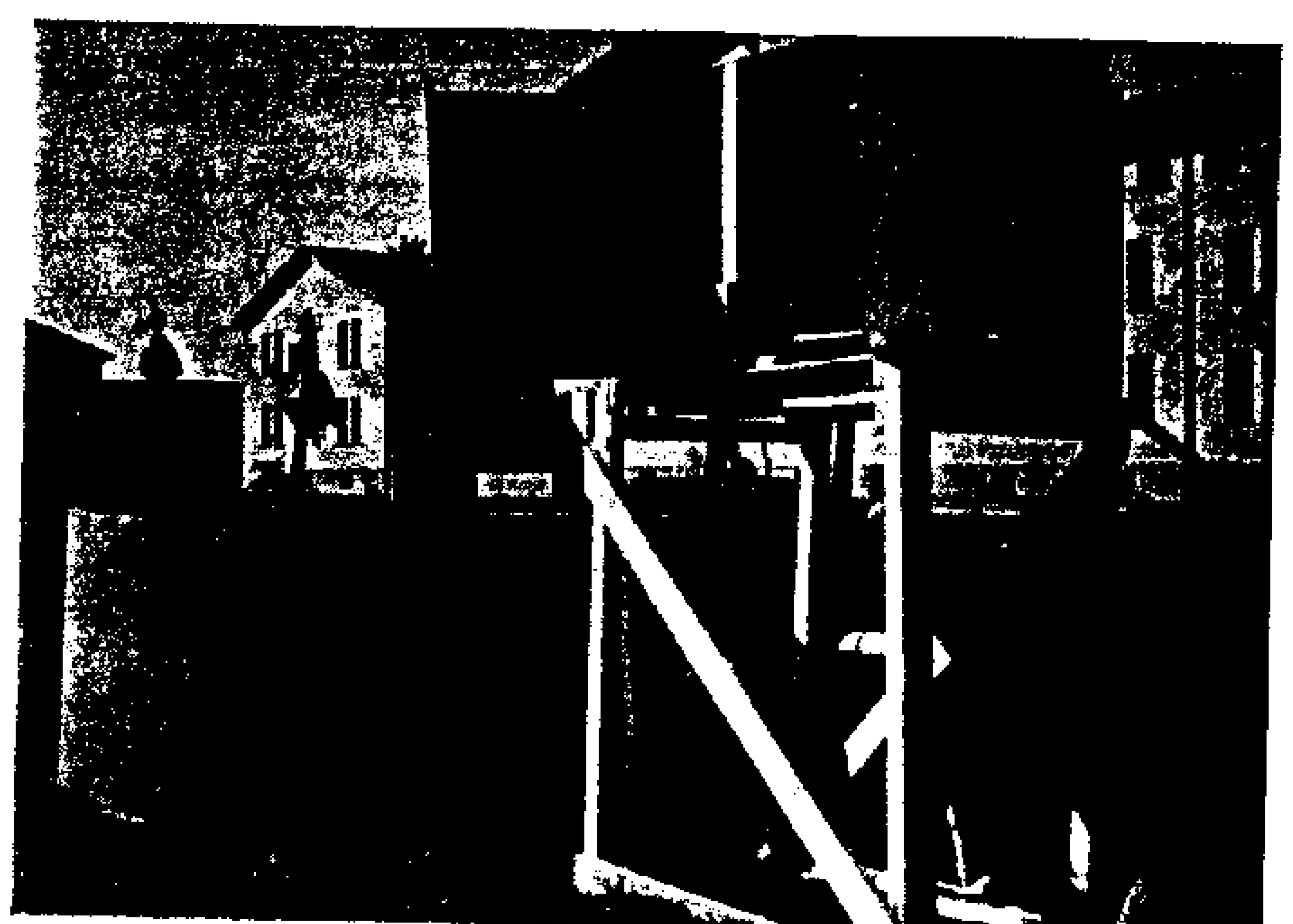


Figure 8. Fiberglass, wastewater-digestion tank and air-blower house (right foreground). The air-blower is elevated to prevent back-siphoning of wastewater into the blower.

clean seawater. The tapwater is not heated in the winter time prior to use, but usually remains around 21 °C. Its use has caused no apparent ill effects to the turtles.

The raceways are fitted on one end with a 10.2 cm (inside diameter) standpipe drain (Figure 7) and a 3.8 cm (inside diameter) drain pipe on the bottom at the same end as the standpipe. The raceways are drained by rotating the 10.2 cm standpipe downward and by opening the valve to the 3.8 cm bottom drain.

The drained seawater and water from scrubbings and rinsings are collected in concrete troughs (Figure 7) that empty into 0.9 meter x 1.8 meter fiberglass sumps located outside the quonset huts. Solid-waste sump pumps transfer this water into two cylindrical, fiberglass, digestion tanks (Figure 8), each 1.5 meters high x 6.1 meters in diameter and holding a volume of 44,570 liters. The waste water from the digestion tanks is drained intermittently into the City of Galveston domestic sewerage system. At the end of each annual head start period, the residual sludge is washed from the digestion tanks into the sewerage system.

Head Start Operations

Hatchlings

Before the hatchlings are transported from Padre Island National Seashore to Galveston they are weighed (wet weight) and measured [carapace length and width, as recommended by Bjorndal and Balazs (1983)] by NPS personnel. The hatchlings are packed in plastic tubs containing polyurethane foam padding soaked with water to prevent dessication of the hatchlings. They arrive at Galveston after two to six hours in transport. NPS personnel pack the boxes in such a way that each clutch is kept segregated from others. Upon arrival at the head start facilities, the hatchlings are first rinsed with seawater and then inspected closely for abnormalities and mortality.

There have been few turtles with abnormalities, but the most common abnormalities that have been observed are: "cross-beak" (upper and lower jaws grossly malformed, left eye missing); concave plastron (plastron grossly depressed); curvature of the spine; shortened spine (turtle much greater in width than in length); plastron improperly healed (unclosed yolk-sac attachment site) and deformed flippers. Turtles with abnormalities are isolated in the sick bay. Turtles with improperly healed plastrons are treated with a topical antibacterial ointment (Terramycin, Gentamycin, Neomycin or Furacin), and in most cases the plastron eventually heals. Abnormal turtles that survive the usual head starting of 9 to 11 months have been transferred to Texas A&M University, to The University of Texas Medical Branch in Galveston or to The University of Texas Institute of Marine Science, Port Aransas to be used for research. Small numbers of these have been transferred by Texas A&M University to Sea Turtle, Inc., directed by Mrs. Ila Loetscher, South Padre Island, Tex.

Clutches of hatchlings are usually assigned to raceways more or less sequentially from raceway to raceway as they are received from NPS. However, in some cases, the turtles have been distributed according to an experimental design (e.g., Caillouet *et al.*, 1989). Clutch identity of each turtle in a raceway is kept track of through the bucket or box location code (Figure 9). For example, the bucket marked with an X in Figure 9 is labeled 83-1-G-4, indicating that the turtle in this bucket was from the 1983 year-class and that the bucket was located in raceway 1, in bucket row G and in bucket column 4. Once an individual turtle is assigned to a container, it usually stays there throughout head starting so that it can be linked through records to its clutch-of-origin and to the female that laid its clutch. In any case, a given turtle can be linked through its container code to recorded details about oviposition, egg collection, incubation, hatching, growth, amount of food fed, health care, etc. One exception is that four hatchlings can be held temporarily within four smaller containers (plastic flower pots) placed in a plastic box. As the turtles grow they are redistributed to larger containers. Another exception is when turtles outgrow their containers. In any case, they are traced according to the code for the container they spend the most time in. For tagged turtles released, the tag number can be linked with the container identification code used during head starting. Computerized data files carry the tag number and container identification code to track data for each turtle.

Foods and Feeding

The food currently in use in the head start research project is a commercially prepared, dry, floating, pelleted diet (Table 2) manufactured by Purina. In 1978, the first year of head start operations, foods such as lettuce and fillet of fish were tried (McKey, J.P., J.K. Leong, R.S. Wheeler and R.M. Harris, unpublished manuscript on culture of Kemp's ridley sea turtle), but the cost and inconvenience of using such foods were prohibitive. A dry, pelleted food manufactured by Central Soya and Subsidiaries of Fort Wayne, Ind., was used between 1979 and 1984 (Caillouet *et al.*, 1986b). After encountering problems with the pellets (they no longer floated), we substituted the Purina diet (Caillouet *et al.*, 1989). The diet prepared by Purina contains 40 percent crude protein, 8 percent crude fat, 5 percent crude fiber, and 47 percent other ingredients (Table 2). This diet provides good growth and survival of the turtles.

Feeding of hatchlings and juveniles must be carefully monitored as overfeeding can result in compaction of the gut and, in extreme cases, death. Because sacrificing live, healthy hatchlings is prohibited, no direct way can be used to

Table 2. Ingredients* of the dry, floating, pelleted diet manufactured by Purina, Richland, Indiana.

Ground yellow corn	Ascorbic acid
Fish meal	Biotin
Soybean meal	Choline chloride
Corn Gluten meal	Folic acid
Meat and bone meal	Pyridoxine hydrochloride
Dried whey	Thiamine
Soybean oil	Niacin supplement
Dehydrated alfalfa meal	Calcium phosphate
Animal fat preserved with BHA,	Riboflavin supplement
Salt	Magnesium oxide
Brewer's dried yeast	Copper sulfate
Dicalcium phosphate	Manganous oxide
Ethoxyquin (a preservative)	Calcium iodate
Vitamin A supplement	Ferrous carbonate
D activated animal sterol (source of vitamin D-3)	Calcium carbonate
Menadione sodium bisulfite (source of vitamin K-activity)	Cobalt carbonate
DL-methionine	Zinc sulfate
Vitamin E supplement	Zinc oxide
Vitamin B-12 supplement	Copper oxide

*Quantities not available. Proprietary information of Purina.

determine when the yolk has been absorbed as a guide to when feeding should start. However, this can be estimated indirectly with samples of hatchlings from each clutch weighed daily. When hatchlings from a clutch start losing weight, as indicated by changes in average weight for the sample, feeding of that clutch is commenced. The time lapse to initiation of feeding is approximately one to two weeks from the hatch date.

The rate at which head started turtles are fed is based on the average weight of a random sample of turtles selected from each raceway at monthly intervals from those surviving during head starting. An adequate sample size was determined to be 25 turtles per raceway (Caillouet *et al.*, 1986b). During the weighings, no attempt is made to dry the turtles. After consecutive weighings of three turtles, the balance pan is dried and re-zeroed. Both mechanical and electronic balances have been used. The initial rate of feeding for hatchlings is roughly five percent of body weight. This rate is gradually changed each month until a rate of roughly 1.5 percent body weight is reached for yearlings. The daily food ration is usually divided into two equal portions, one fed in the early morning and the other in late afternoon. The rations of food are distributed to the turtles using small plastic cups that hold the measured volume of feed required to deliver a given weight of feed. Geometric mean weights are preferred to arithmetic mean weights for setting feeding rates, because it has been found that the variances of weights of head started Kemp's ridleys are heterogeneous and a logarithmic transformation alleviates this problem (Caillouet *et al.*, 1986b; Caillouet *et al.*, 1989).

Health Care

During head starting, each turtle receives a precursory examination for evidence of disease during the twice daily feeding. Any turtle displaying signs of disease or injury is isolated at that time in the sick bay. Others with more serious problems are submitted to Joseph Flanagan, DVM, Houston Zoo, for clinical diagnosis and treatment (see also Clary and Leong, 1984; Leong *et al.*, 1989).

Necropsy

If a turtle dies, its kidneys and gonads are removed and preserved in 10 percent buffered formalin for sex determination (Wibbels *et al.*, 1989). If several die at once or from the same raceway the turtles are put on ice and taken to the Texas Veterinary Medical Diagnostic Laboratory Systems in College Station for a thorough necropsy. Treatments recommended for remaining sick turtles can then be implemented.

Tagging

The head started turtles are tagged by three different methods (Fontaine *et al.*, 1989) before being released into the Gulf of Mexico:

1. A living-tag technique developed by Dr. John and Mrs. Lupe Hendrickson, University of Arizona, Tucson involves surgical removal of small pieces of plastron and carapace, interchanging the grafts, and securing them with histological glue. As the turtles grow, the lighter colored plastron transplant makes a vivid mark on the otherwise darker background of the carapace (Figure 10). By placing the tag on a different scute each year, the year-class can be determined for turtles later recaptured or found (Caillouet *et al.*, 1986a; Fontaine, Williams and Caillouet, 1988)). We do not expect anyone but the informed observer to recognize such a tag.
2. An internal, binary coded, magnetic tag, manufactured by Northwest Research Technology Corporation, Shaw Island, Wash., is injected into the tip of the right front flipper (Figure 11). The tags are 2 mm in length. They are sterilized and the area of flipper where the tag is to be injected is swabbed with tincture of iodine. Once in the turtle, the tag is magnetized by running a magnet over the flipper. The tag can be detected by a magnetometer. The flipper can also be X-rayed to determine the exact location of the tag. If the turtle is dead when found, the tag can then be surgically removed and the year-class determined. We do not expect anyone but those equipped with magnetometer or X-ray devices to detect and locate such tags. However, if the carcasses of tagged turtles that are found dead are made available to us, we can check for presence of the tags. It is also possible that a hand-held magnetometer may be developed for future use in field studies. In any case, these internal tags are expected to be life-time tags and should remain in place for future reference.
3. Flipper tags (Figure 12) are the most frequently used tags, and are easily recognizable as tags by the public, but we do not consider them to be lifetime tags. Flipper tags used for head started Kemp's ridley are Hasco type, style 681, self-piercing, self-clinching, ear tags, manufactured from monel or inconel by National Band and Tag Company, Newport, Ky. They are inscribed with a sequential letter-number code as well as the message "Send NMFS Lab, Virginia Key, Miami, FL 33149." Tagging with this tag is usually done about 30 days prior to release of the turtles to allow remedial action in case of tag loss or infection, and to allow time for tag-related mortality, if any, to be observed. The tags are normally inserted on the trailing edge of the right front flippers. The tags are first soaked in gasoline for 24 hours to remove any oil or grease, then in 90 percent ethanol for 24 hours and, finally, they are sterilized by autoclaving prior to tagging. The area of tag insertion on the flipper is swabbed with tincture of iodine prior to tagging. Neosporin, a broad-spectrum anti-bacterial ointment, is applied to the tip of the sharp clasping device of the tag before the tag is inserted. A cast-iron, tagging tool (National Band and Tag Company) is used to affix the tag to the flipper. It is sometimes necessary to recrimp the tag with pliers to secure it. Careful observations of tag codes, body weight, carapace length and width (straight line), and gross observations of general condition and health of each turtle are made and recorded as each tag is applied. This usually is the last time that measurements and weights of the head started turtles are recorded before the turtles are released. Turtles do not actively feed for one to two days after tagging, so feeding is discontinued for 48 hours. This procedure prevents fouling the water with uneaten food.

Release

Head started Kemp's ridleys are transported to release sites in wax-coated, cardboard boxes. The boxes are modified by partitioning them with plywood to make two horizontal layers within each box (Figure 13). Two 1.3 cm air-holes are drilled at each end of the box, and the floor of each layer is covered with a piece of 1.3 cm thick polyurethane foam to cushion the turtles. The foam is moistened with water to prevent dessication of the turtles during transit. Eight yearling turtles are transported in each box, four turtles to a layer. Turtles are oriented with their heads toward the corners of the box to prevent them from biting each other, and to place their heads nearer the air-holes. The lid of the box is secured with gray duct tape, one piece completely around the length of the box and another completely around the width.

Copies of federal and state permits are attached to each box. Normally, a crew of 10 persons requires three hours to pack and load the yearling turtles for shipment. Packing and loading should be done as quickly as possible and at night to reduce the amount of time that turtles are held in the boxes and to prevent their becoming over-heated. The turtles remain in the boxes until released from a vessel.

Since 1981, the release site for the 9- to 11-month-old turtles has been offshore of Padre Island (Fontaine *et al.*, 1989). This site was chosen to reinforce any imprinting the turtles might have received as eggs and hatchlings at Padre Island. Transit by truck and vessel to the release site takes about 10 hours. Either U.S. Coast Guard cutters or The University of Texas' R/V LONGHORN have been used in most of the releases.

Figure 10. Living tag on a 1984 year-class Kemp's ridley sea turtle. The tag is on left costal scute 5.

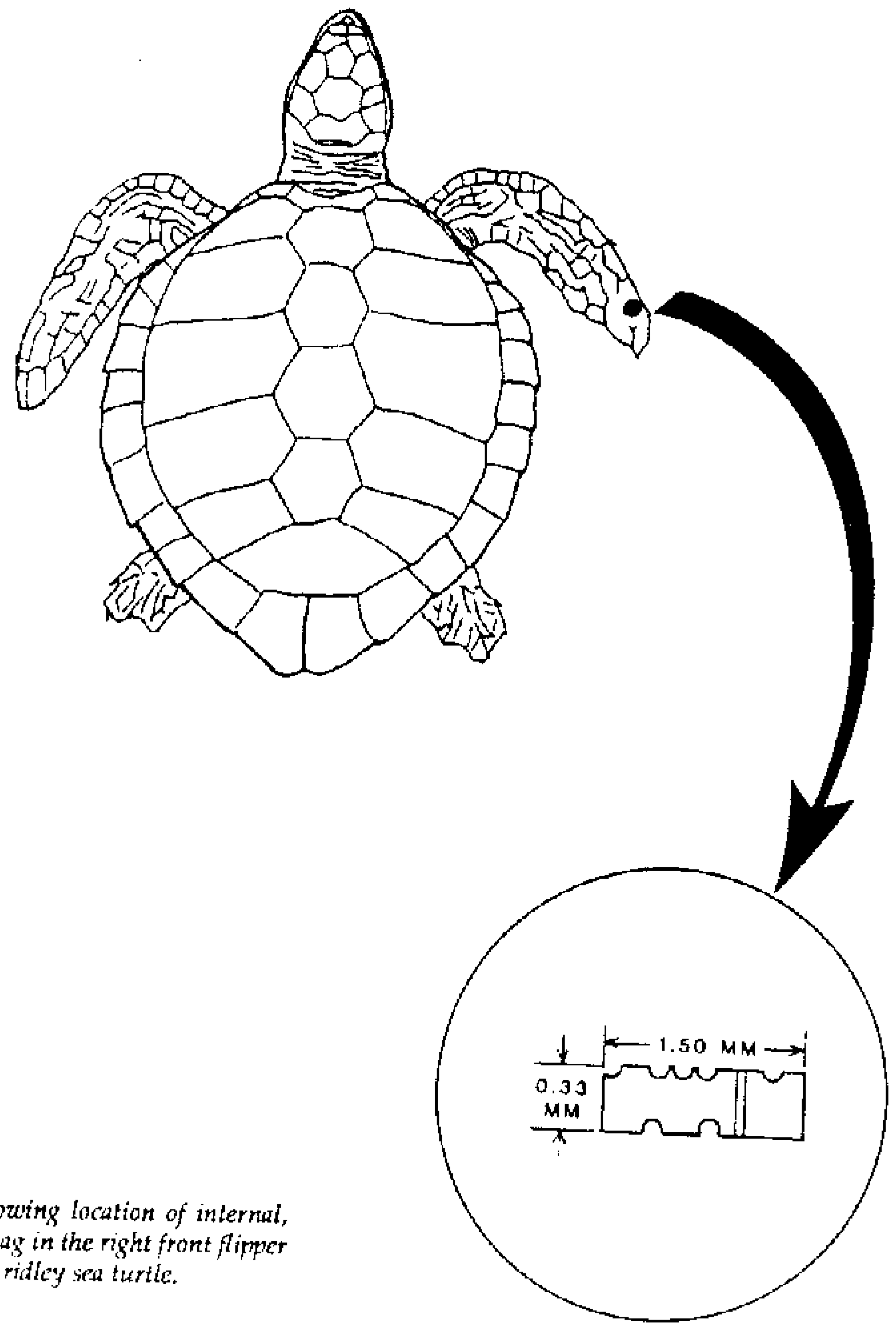


Figure 11. Diagram showing location of internal, binary-coded, magnetic tag in the right front flipper of a head started Kemp's ridley sea turtle.

Figure 12. Flipper tag (Hasco type, style 681, self-piercing, self-clinching) used on head started Kemp's ridley sea turtles.

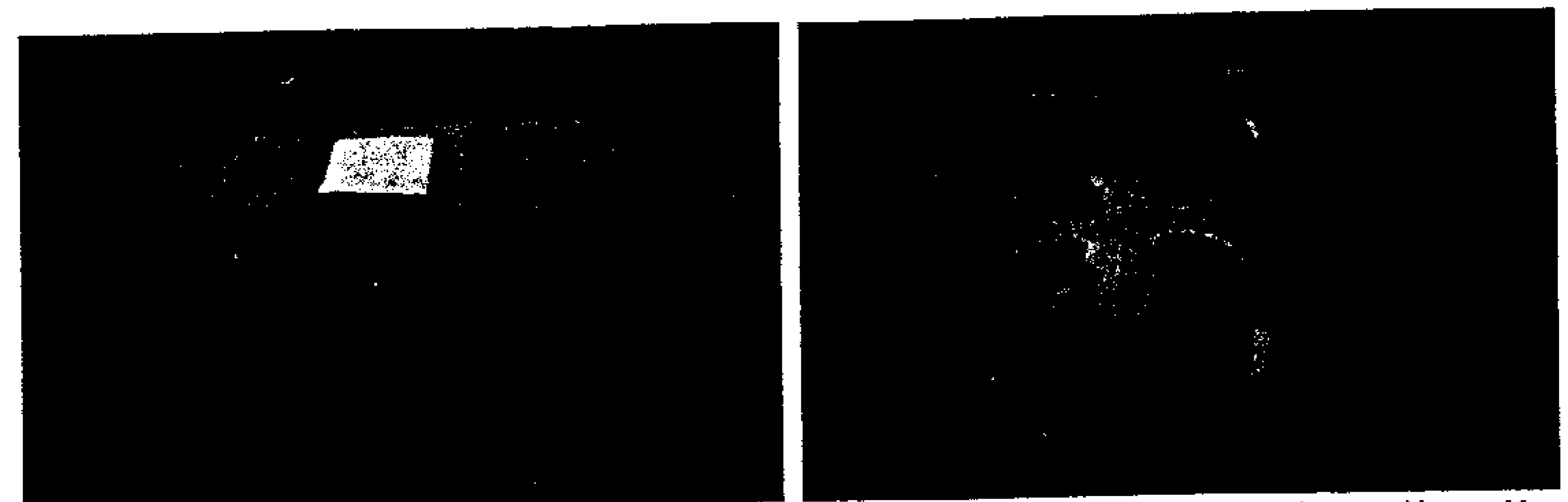


Figure 13. Wax-coated box used to transport tagged yearling Kemp's ridley sea turtles. Usually, eight turtles (two horizontal layers of four each; right photo, cutaway) are transported in this manner to the release site.

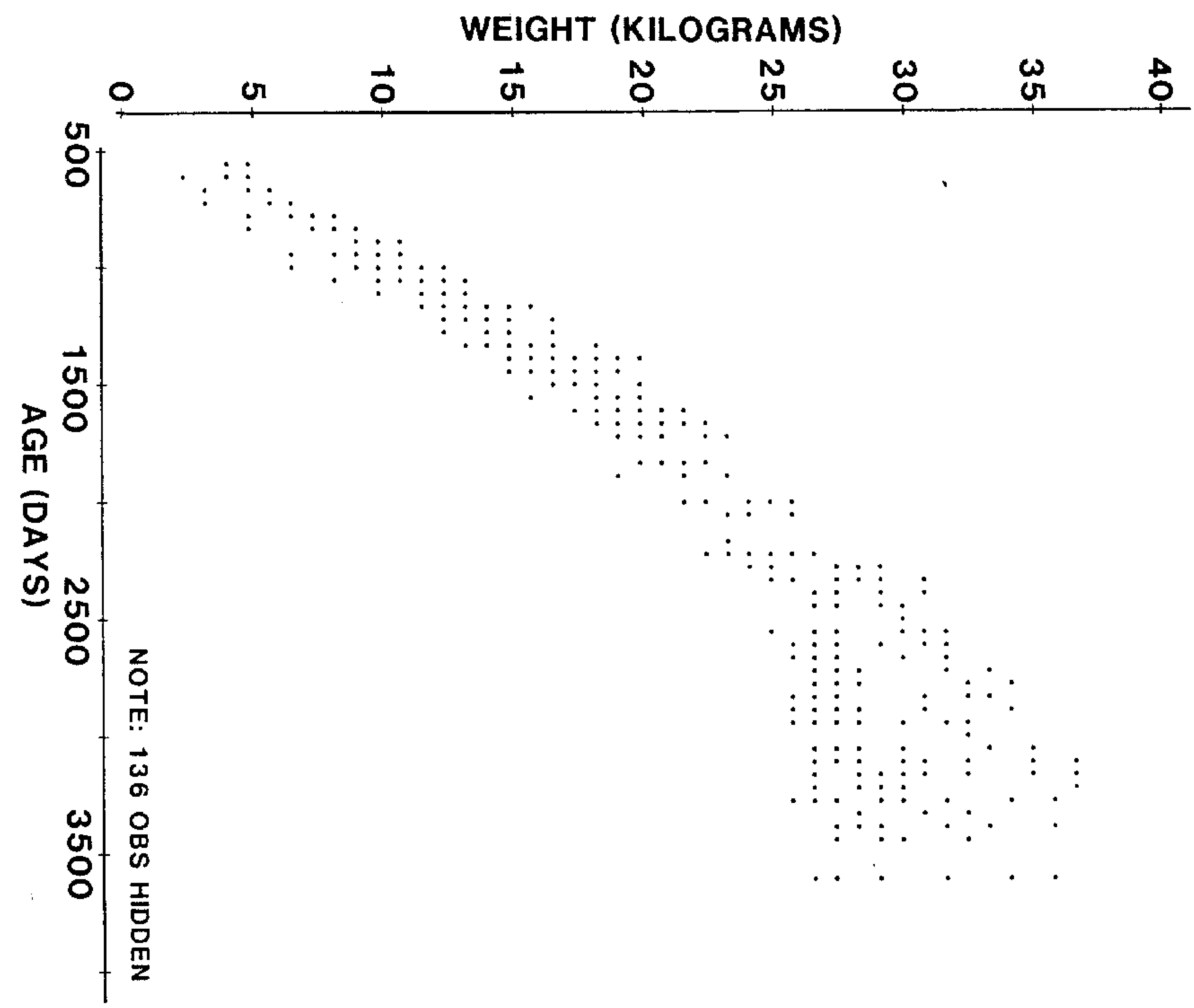


Figure 14. Weight (kg) versus age (days) for 10 head started Kemp's ridley sea turtles of the 1978 year-class held in captivity at Sea-Arama Marineworld.

Table 3. Summary of Kemp's ridley sea turtle head start results for year-classes 1978-1988 [a]

Year-class	Number of live hatchlings received	Number of dead hatchlings received	Mortality during head starting	Number of survivors	Percent survival[b]	Number of turtles held back for research[c]	Number of tagged turtles released	Percent released[b]
1978	3,080	1	992	2,088	67.8	42	2,019 [d]	65.6
1979	1,843	3	315	1,528	82.9	166	1,345 [e]	73.0
1980	1,815	7	84	1,731	95.4	0	1,723 [f]	94.9
1981	1,864	1	225 [g]	1,639	87.9	0	1,639	87.9
1982	1,524	0	171	1,353	88.8	28	1,325	86.9
1983	250	0	58	192	76.8	2	190	76.0
1984	1,441	106	361	1,080	74.9	63	1,017	70.6
1985	1,684	8	138	1,546	91.8	12	1,534	91.1
1986	1,759	0	29	1,730	98.4	50	1,680	95.5
1987	1,278	4	126	1,152	90.1	50	1,100 [h]	86.1
1988	925	0	14	911	98.5	-	-	-
Total	17,463	130	2,513	14,950	84.9[i]	413	13,572	82.1[i]

[a]As of 31 October 1988, except for the 1988 year-class which status is as of 13 October 1988.
[b]Based on number of hatchlings received alive. See footnote a.
[c]Included abnormal, injured or sick individuals that could not be released and normal, healthy animals held for extended head starting and captive propagation experiments.
[d]27 turtles died in transit.
[e]17 turtles died in transit.
[f]8 turtles died in transit.
[g]Included 2 turtles unaccounted for but presumed dead.
[h]2 turtles died in transit.
[i]Based on 1978-1987 year-classes only.

Results

As of October 31, 1988, 13,572 Kemp's ridley sea turtles had been head started, tagged and released into the Gulf of Mexico (Table 3). This represents 82.1 percent of the 1978-1987 year-class hatchlings received alive from the NPS. As of October 31, 1988, 589, or 4.3 percent, had been recaptured. Distribution, growth and survival of head started turtles in the wild were described by Fontaine *et al.* (1989) and Manzella, Caillouet and Fontaine (1988). Growth and movements of head started Kemp's ridleys in the wild also have been described by McVey and Wibbels (1984).

Since 1978, 264 head started Kemp's ridley have been transferred to oceanaria for extended head starting or captive propagation. As of the end of October 1988, 100 survivors remained in captivity. Growth in weight of head started Kemp's ridley of the 1978 year-class at Sea-Arama Marineworld, Galveston, Tex., is shown in Figure 14 (see also McVey and Wibbels, 1984; Caillouet *et al.*, 1986b).

A summary of head starting Kemp's ridleys in captivity is shown in Table 3. Survival and growth of head started Kemp's ridleys in captivity have been described by Caillouet *et al.* (1986b). The combined survival rate for the seven year-classes was 84.9 percent (Table 3). Survival and growth of head started Kemp's ridleys in the wild appear to be good (Fontaine *et al.*, 1989), but we cannot gauge the success of maturation, copulation and nesting of such animals in the wild as none of the released turtles have been reported to have nested.

In 1984, egg laying was reported in two 5-year-old, head started Kemp's ridleys maintained in captivity at Cayman Turtle Farm (Wood and Wood, 1984). According to Wood and Wood (1984), more than 60 eggs were laid by the sea turtles in May 1984. Three of the eggs in one clutch hatched, indicating that copulation and fertilization had occurred. Unfortunately, the three hatchlings did not live. Successful reproduction (that which produces viable hatchlings) has since occurred in the captive stock of Kemp's ridleys at the turtle farm in 1986, 1987 and 1988, and some of the hatchlings were head started in Galveston. These events indicate that captive propagation of Kemp's is feasible, and could provide a safety net for the species (Caillouet, 1984).

Public awareness of the head start project is so great that the turtles have become celebrities on the Texas coast. The facilities provide a common site for field trips for many local schools in the Houston-Galveston area. A book (Phillips, 1989) recently has been published popularizing the project. Annually, thousands of visitors tour the project site. HEART (Help Endangered Animals - Ridley Turtles), a special committee of the Piney Woods Wildlife Society, North Harris County College, Houston, Tex., sponsors a one day open house in February that attracts hundreds of visitors to the facility. The annual release of turtles also is a very much publicized event. Local and national news teams cover the release. Such media coverage helps convey the message of the need for sea turtle conservation to the public.

Recommendations

We believe there are four areas of research that should be emphasized in furture work:

1. Tags and tagging of sea turtles – None of the tags presently being used adequately meet the need. A tag or mark is needed that will last the entire life of the tagged turtle, and that can be easily recognized and identified by whomever recaptures a Kemp's ridley. The PIT (passive integrated transducer) tag shows promise as a permanent tag, and we are testing it. Further, through publicity and through changes in the message on the flipper tags, the finders of a tagged turtle could be encouraged to take the needed observations and report them in a timely manner without removing the tag from live animals. Carcasses of tagged animals that die in the captive stock or are found dead after release should be saved for examination, as these specimens provide a means of evaluating tag recognition and retention, as well as provide valuable information on possible causes of death.
2. Sex determination – A simple technique must be developed to determine the sex of live hatchlings and juveniles without injuring them. Sex determination is essential for proper management and conservation of this endangered species, because sex ratios of hatchlings are affected by incubation temperature. The hormonal studies by Dr. David Owens, Texas A&M University, and his students are encouraging in this regard. Laparoscopy also has been used successfully by Dr. Owens and his students on large juvenile and adult turtles, but neither technique is simple nor applicable to hatchlings and small juveniles. However, the non-injurous approach used by Demas *et al.* (manuscript) shows promise.
3. Reproductive physiology and behavior – Additional information is needed on reproduction in the wild and in captivity.
4. Prevention, recognition, diagnosis and treatment of diseases – These must be improved for captive stocks of Kemp's ridley. The successful captive-rearing of Kemp's ridleys depends to a large extent upon prevention and control of diseases encountered in the husbandry of this species. Improvements in seawater systems that provide high quality seawater for captive rearing of sea turtles go far toward reducing disease problems. Other environmental influences (e.g., temperature, sunlight, etc.) also may affect the incidence of diseases. Good nutrition is another important factor.

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Questions and Answers

***Sally Murphy:** I am not quite sure I understood what you said about hatchling emergence - that hatchlings were emerging in the morning and that this is different from the natural condition. When do they normally emerge?*

King: Pat Burchfield mentioned that he was watching normal emergence at the Rancho Nuevo beach just prior to sunrise.

Burchfield: René Márquez and I decided, in light of some of the experimental imprinting work that is being done, that during the 1985 nesting season we wanted to determine whether there were any relationships between hatchling emergence times and beach temperatures, incubation and so on. Unfortunately, we did not have our data analysis complete for this meeting. About 70 percent of the hatchling ridleys that emerged out of 117 nests from June 13, 1985 to the end of the season would have essentially been in the water before sunrise. Hatchling emergence started about 2300 hours the preceeding evening and continued through 0900 hours the following morning. But the majority of the turtles would have been in the water before sunrise.

***Peter Pritchard:** You mentioned that the hatchlings needed to be heated up a little before they were active enough to walk down the sand, and the general opinion from Mrosovsky's* et al. *observations was that sea turtles tend to slow down in activity when temperature rises above a certain critical level about 29° C, if I recall correctly. Are these compatible with each other? In other words, at what temperature did you find they were active? How low was the temperature when they were too cold to move?*

King: During the night, when the hatchlings are in the transfer boxes prior to their transfer from the incubation shed to the beach for imprinting, the temperature drops to 72°-74° F (22°-23° C). I would imagine that the hatchlings were at that same temperature. At 0800 hours, when the sun is rising, the hatchlings are still at the lowered temperature. On exposure to the sun, their temperature begins to rise. I would guess that by the time they start moving down to the water, the temperature, in most cases, is somewhere between 75° F and 85° F (24° - 29°C).

***Pritchard:** Do you think you could lower the peak temperature in the egg boxes and perhaps make it occur later in the day by using thicker boxes or double boxes?*

King: The holes that must be put through the boxes to ensure good ventiliation throughout the sand probably would counteract any benefits of thicker walls. Thickness of the foam material does not seem to make a difference. For example, we doubled the thickness of the foam walls changing from the old boxes used in 1982 to the newer boxes used in 1983, and this did not seem to change the temperature curve at all. This change was from 1/2 inch (1.3 cm) to 1 inch (2.5 cm) thick.

Caillouet: It is generally accepted that incubation temperature affects the sex ratio in sea turtles. However, it seems to me that two quite different results might derive from this. Either sea turtles that become male or female have identical sex genotypes and their phenotypic sex is somehow induced by incubation temperature or they have male and female genotypes that can be overcome by temperature. If the latter were true, then it follows that a certain proportion of the animals would become sex-reversed in the process of incubation at temperatures conducive to induction of the sex that is inconsistent with the sex genotype. We should be concerned about the possible affects of such sex reversal. For example, it may be that sex-reversed animals, even though they are phenotypically females, may not have the same biotic potential or survivability as females that are not sex-reversed.

***John Carr:** Do you have an idea at which stage of development the carapacial scutes pattern is determined or finalized?*

Shaver: I did not examine the scutes because oftentimes the embryos were in very bad condition. They were frequently deformed. If I recall correctly, it is approximately at stages 25 and 26 that the scutes begine to appear.

***Carr:** What is the full number of stages in development?*

Shaver: Cratz described 31. We added four more because his stages left out a lot of measurements. Applying his stages to our embryos would have made it impossible to characterize some of our embyros.

***Pritchard:** How many days would that be, when scutes first can be seen, more or less?*

Shaver: It is about 33 days.